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(54) METHODS AND SYSTEMS EMPLOYING A CONDUCTIVE PATH WITH A SEGMENTATION MODULE FOR DECOUPLING POWER AND TELEMETRY IN A WELL

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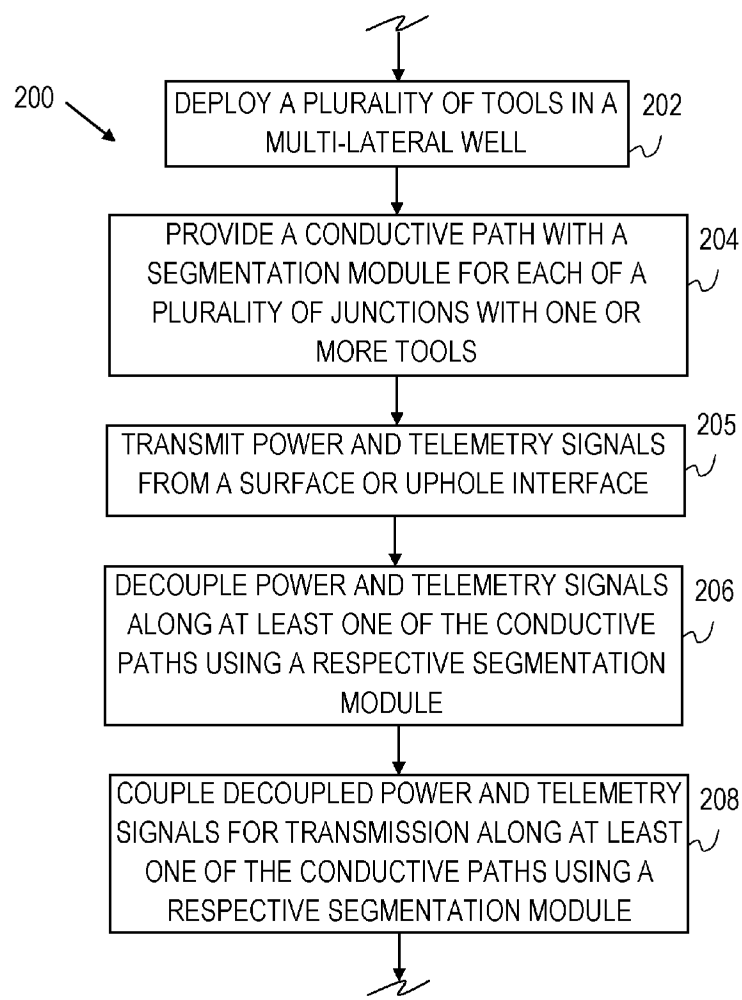
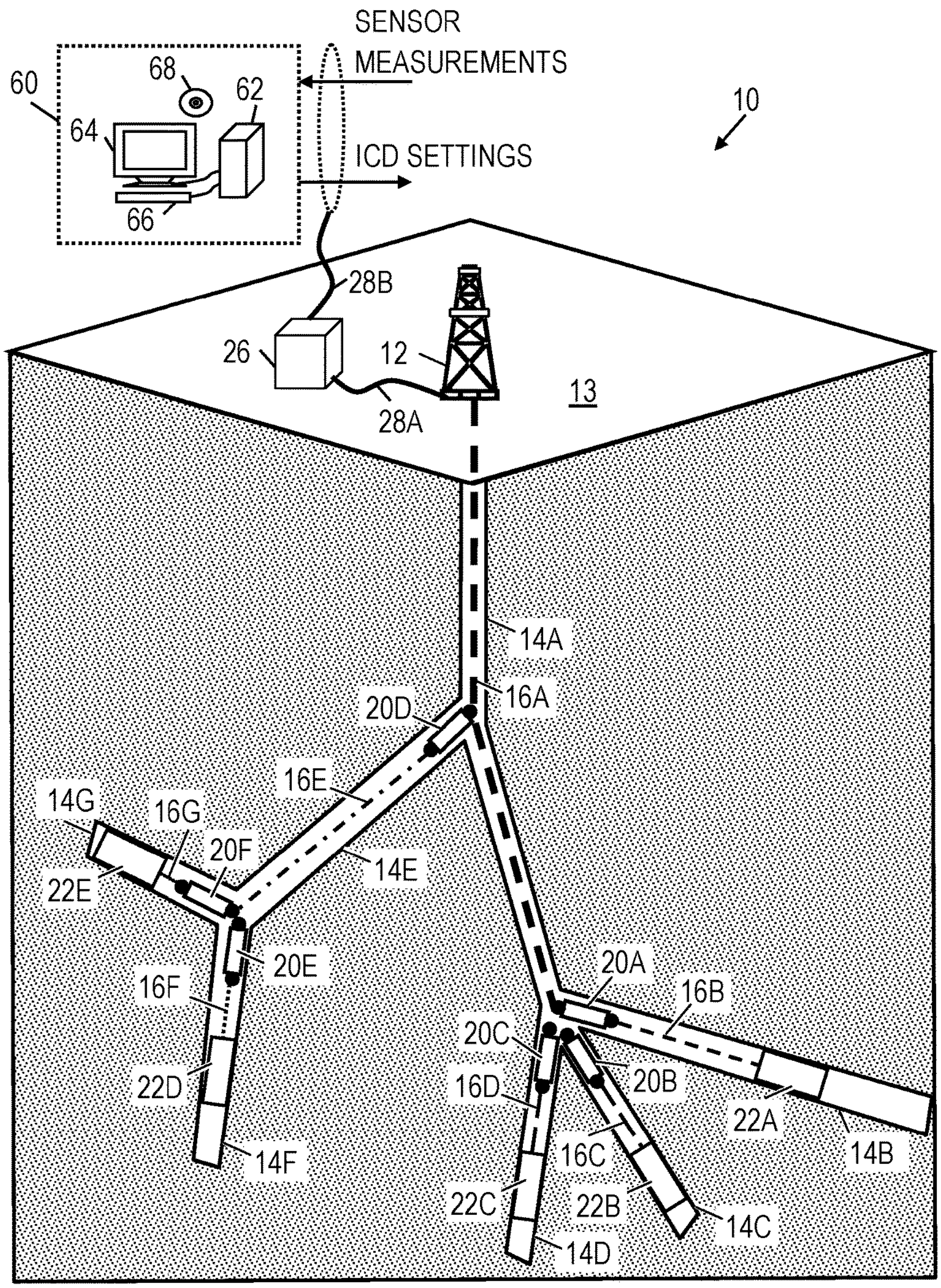
(57) ABSTRACT

A method includes deploying a tool in a well. The method also includes providing a conductive path with a segmentation module in the well. The method also includes conveying power and telemetry signals from a surface or uphole interface to the tool via the conductive path, where conveying the power and telemetry signals includes the segmentation module decoupling and later coupling power and telemetry signals conveyed along the conductive path.




SENSOR
MEASUREMENTS
ICD SETTINGS
60
68
62
64
66
10
28B
26
12
13
28A
14A
16A
20D
16E
14G
16G
20F
14E
22E
20E
16F
22D
14F
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14B
16C
22C
22B
14C
14D

FIG. 1

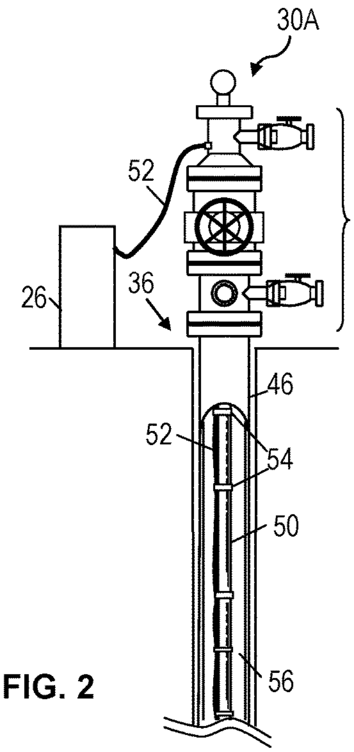



FIG. 2

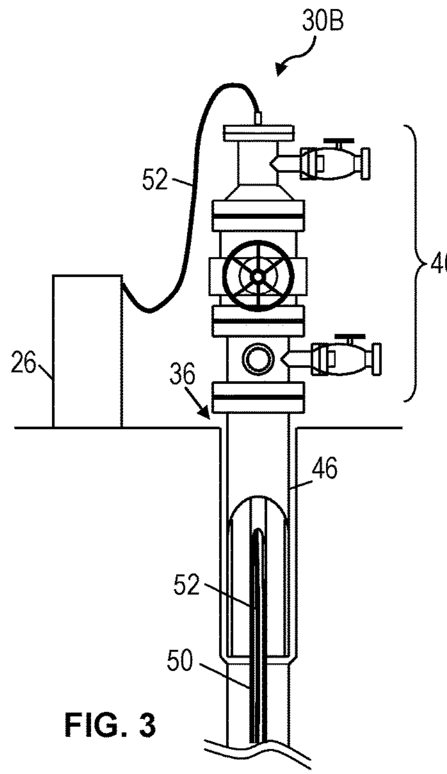



FIG. 3

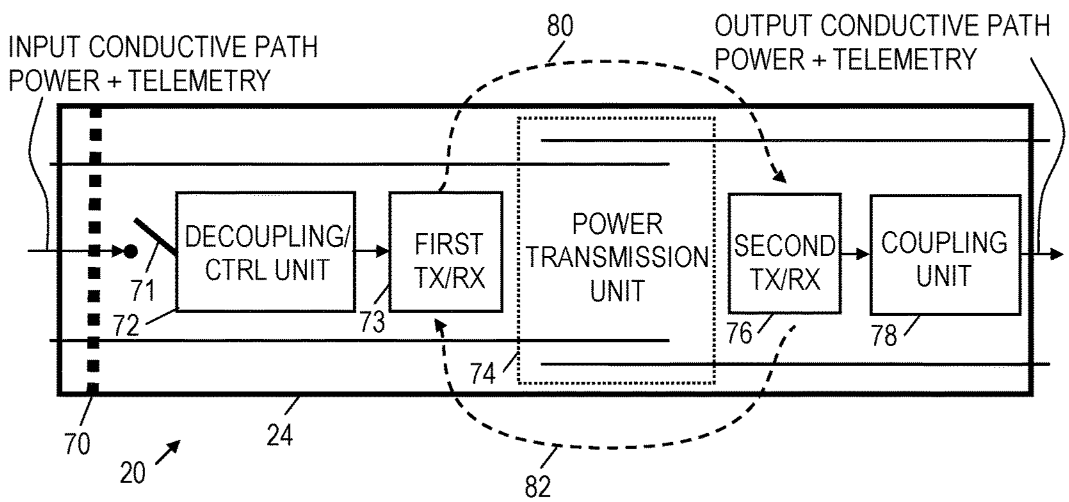



FIG. 4

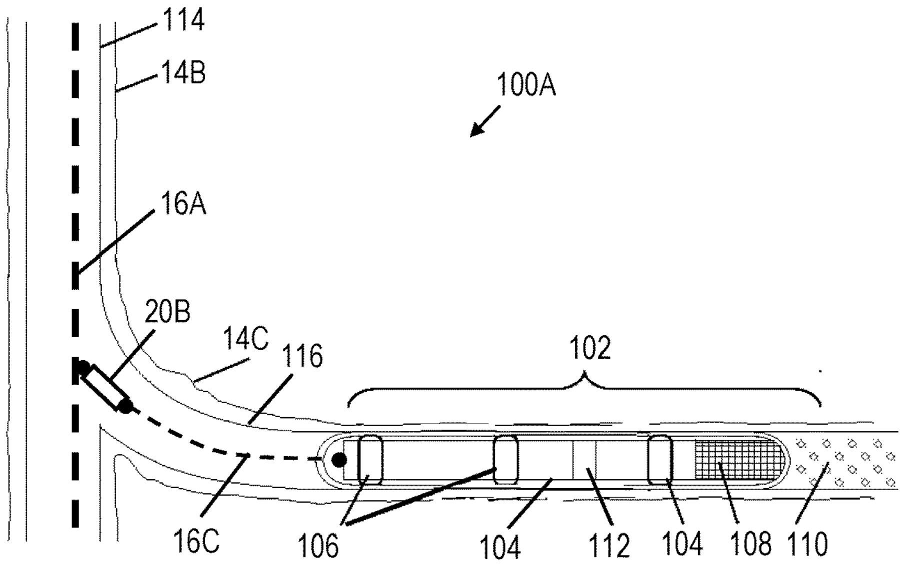
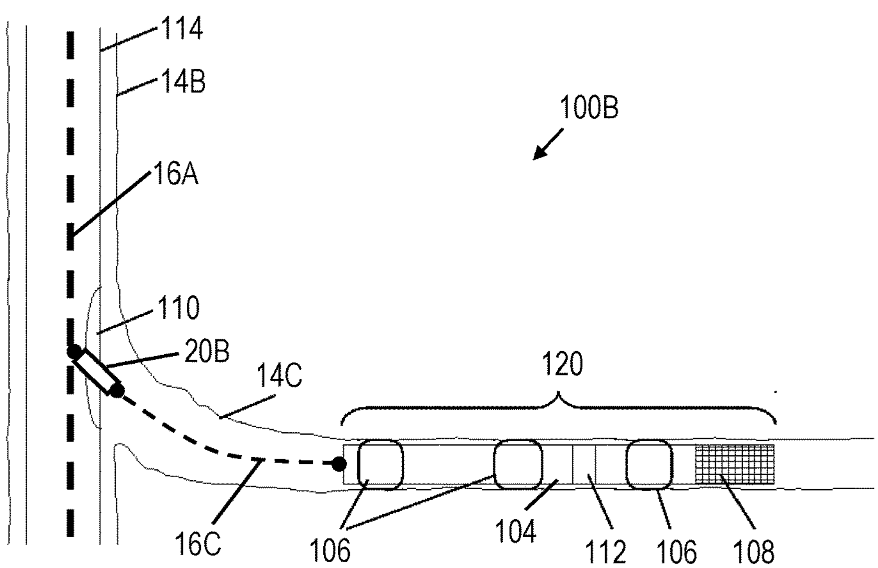

114
14B
100A
16A
20B
14C
116
102
16C
106
104
112
104
108
110

FIG. 5A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100B
16A
110
20B
14C
120
16C
106
104
112
106
108

FIG. 5B

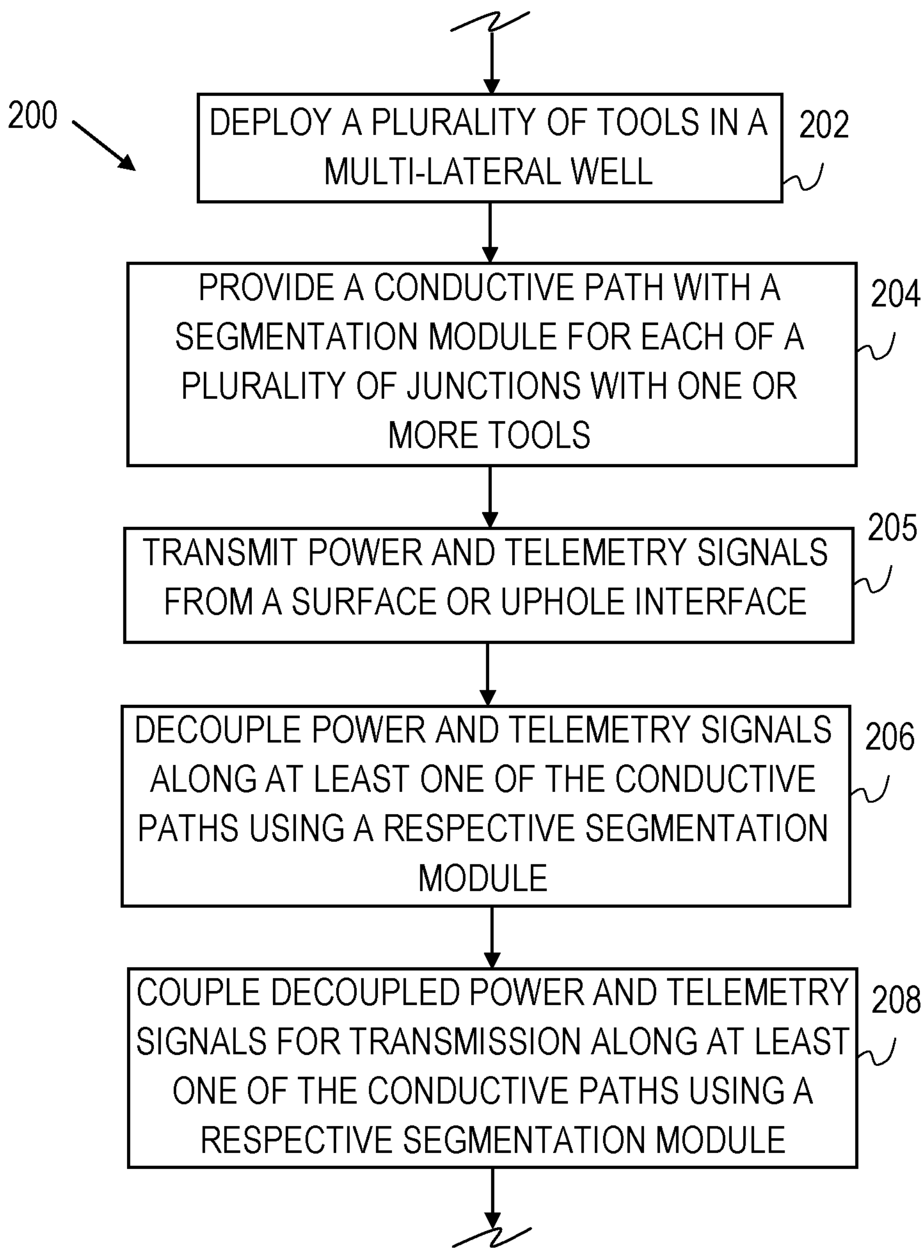
200
DEPLOY A PLURALITY OF TOOLS IN A MULTI-LATERAL WELL
202
PROVIDE A CONDUCTIVE PATH WITH A SEGMENTATION MODULE FOR EACH OF A PLURALITY OF JUNCTIONS WITH ONE OR MORE TOOLS
204
TRANSMIT POWER AND TELEMETRY SIGNALS FROM A SURFACE OR UPHOLE INTERFACE
205
DECOUPLE POWER AND TELEMETRY SIGNALS ALONG AT LEAST ONE OF THE CONDUCTIVE PATHS USING A RESPECTIVE SEGMENTATION MODULE
206
COUPLE DECOUPLED POWER AND TELEMETRY SIGNALS FOR TRANSMISSION ALONG AT LEAST ONE OF THE CONDUCTIVE PATHS USING A RESPECTIVE SEGMENTATION MODULE
208

FIG. 6

# METHODS AND SYSTEMS EMPLOYING A CONDUCTIVE PATH WITH A SEGMENTATION MODULE FOR DECOUPLING POWER AND TELEMETRY IN A WELL

## BACKGROUND

**[0001]** Oilfield operating companies seek to maximize the profitability of their reservoirs. Typically, this goal can be stated in terms of maximizing the percentage of extracted hydrocarbons subject to certain cost constraints. A number of recovery techniques have been developed for improving hydrocarbon extraction. Some modern wellbores are multi-lateral wells, where lined and/or unlined lateral wells branch off from a main wellbore or branch.

**[0002]** For a multi-lateral well, maximizing the percentage of extracted hydrocarbons may involve deploying and controlling in-flow control device (ICD) or other tools in each of a plurality of lateral or sub-lateral branches. Without such control, the limited fluid flow capacity of a multi-lateral well can be negatively affected by lateral or sub-lateral branches that produce water or that cause negative hydrocarbon flows (due to pressure variations).

**[0003]** Providing power and telemetry to ICDs or other tools in a multi-lateral well is not a trivial task. For example, as the number of tools deployed in a multilateral frame work increases, the total amount of power needed and the complexity of power distribution to operate these tools increases. Further, communications between tools deployed in a multilateral frame work and earth's surface is an ongoing challenge that increases in complexity as the number of tools deployed in a multilateral frame work increases. Unlimited power is generally not available at production sites, and high-power solutions increase the likelihood of injury to operators at earth's surface. Further, the need for increased power, the need for signal amplification, and the likelihood of a break in conductive path continuity increases as a function of wellbore length. Further, work over operations (e.g., to maintain or repair a wellbore) often involve removing production tubing or other well components, which can affect conductive path continuity.

## DESCRIPTION OF THE DRAWINGS

**[0004]** Accordingly, there are disclosed in the drawings and the following description methods and systems employing conductive paths with segmentation modules for decoupling power and telemetry in a multi-lateral well. In the drawings:

**[0005]** FIG. **1** is a schematic diagram showing an illustrative multi-lateral well scenario with segmentation modules;

**[0006]** FIGS. **2** and **3** are schematic diagrams showing illustrative conductive path deployment options;

**[0007]** FIG. **4** is a block diagram showing an illustrative segmentation module;

**[0008]** FIGS. **5**A and **5**B are schematic diagrams of illustrative lateral wellbores with in-flow control devices (ICDs); and

**[0009]** FIG. **6** is a flow chart showing an illustrative method involving conductive paths with segmentation modules for decoupling power and telemetry for multi-lateral well tools.

**[0010]** It should be understood, however, that the specific embodiments given in the drawings and detailed description thereto do not limit the disclosure. On the contrary, they provide the foundation for one of ordinary skill to discern the alternative forms, equivalents, and modifications that are encompassed together with one or more of the given embodiments in the scope of the appended claims.

## DETAILED DESCRIPTION

**[0011]** Disclosed herein are methods and systems employing conductive paths with segmentation modules for decoupling power and telemetry in a multi-lateral well. The power and telemetry can be used to direct or collect data from in-flow control devices (ICDs) or other tools deployed in lateral or sub-lateral branches of the multi-lateral well. In at least some embodiments, the conductive paths and/or segmentation modules can be deployed downhole by being mounting to or attached to downhole tubular components (e.g., a production string and/or liners) deployed in the multi-lateral well. Each segmentation module can support various features such as adjusting decoupled power or telemetry signals (e.g., boosting a telemetry signal or changing the current/voltage levels of the power signals), or providing an on/off switch along a conductive path (e.g., at a junction of the multi-lateral well). Further, each segmentation module may enable disconnecting and reconnecting one of the conductive paths (e.g., at a junction of the multi-lateral well). As an example, the ability to disconnect and reconnect a conductive path enables removal of downhole tubular components deployed in a multi-lateral well for work over operations or other downhole operations. Once the downhole operations are completed, the same downhole tubular components or replacement downhole tubular components can be deployed again along with any conductive path components and/or connectors needed to reconnect a conductive path at a respective segmentation module that remains in the multi-lateral well.

**[0012]** In at least some embodiments, an example method includes deploying a plurality of tools in a multi-lateral well. The method also includes providing a conductive path with a segmentation module for each of a plurality of junctions of the multi-lateral well associated with one or more of the plurality of tools. The method also includes decoupling power and telemetry signals along at least one of the conductive paths using a respective segmentation module. The method also includes coupling decoupled power and telemetry signals along at least one of the conductive paths using a respective segmentation module. Meanwhile, an example system includes a plurality of tools deployed in a multi-lateral well. The system also includes a conductive path with a segmentation module for each of a plurality of junctions of the multi-lateral well associated with one or more of the plurality of tools, wherein at least one of the segmentation module decouples and later couples power and telemetry signals along its respective conductive path. Various options for segmentation module deployment, segmentation module components, segmentation module features, and segmentation module use in a multi-lateral well are disclosed herein.

**[0013]** FIG. **1** is a schematic diagram showing an illustrative multi-lateral well scenario **10** with segmentation modules **20**B-**20**G. In scenario **10**, surface equipment **12** at earth's surface **13** enables production and/or well intervention operations for a multi-lateral well having a is main wellbore with an upper portion **14**A and a lower portion **14**B. Lateral wellbores **14**C and **14**D extend from the lower portion **14**B of the main wellbore (or from the junction of the upper portion **14**A and the lower portion **14**B). Meanwhile, lateral wellbore **14**E extends from the upper portion **14**A of the main wellbore. Further, sub-lateral wellbores **14**F and **14**G extend from the lateral wellbore **14**E.

**[0014]** In scenario **10**, various conductive paths **16**A-**16**G are represented. Without limitation to other embodiments, the conductive paths **16**A-**16**G may correspond to tubing encased conductors (TECs) and suitable connectors. More specifically, the conductive path **16**A extends along the upper portion **14**A of the main wellbore, the conductive path **16**B extends along the lower portion **14**B of the main wellbore, the conductive path **16**C extends along the lateral wellbore **14**C, the conductive path **16**D extends along the lateral wellbore **14**D, the conductive path **16**E extends along the later wellbore **14**E, the conductive path **16**F extends along the sub-lateral wellbore **14**F, and the conductive path **16**G extends along the sub-lateral wellbore **14**G.

**[0015]** Each of the represented segmentation modules **20**A-**20**F in scenario **10** is positioned between two of the conductive paths **16**A-**16**G. More specifically, segmentation module **20**A is between conductive paths **16**A and **16**B, segmentation module **20**B is between conductive paths **16**A and **16**B, segmentation module **20**C is between conductive paths **16**A and **16**D, segmentation module **20**D is between conductive paths **16**A and **16**E, segmentation module **20**E is between conductive paths **16**E and **16**F, and segmentation module **20**F is between conductive paths **16**E and **16**G. While conductive paths **16**A-**16**G are described in a segmented manner, it should be appreciated that when certain segmented conductive paths and segmentation modules are joined together, they form a continuous conductive path (e.g., extending between earth's surface and a particular tool).

**[0016]** In scenario **10**, various tools **22**A-**22**E are deployed in the multi-lateral well. The tools **22**A-**22**E may correspond to ICDs or other tools used to control flow in either direction of a lateral or sub-lateral wellbore. Further, tools **22**A-**22**E may include sensors to monitor ambient parameters such as pressure, temperature, flow rate, vibration, or other parameters. In scenario **10**, tool **22**A is deployed in the lower portion **14**B of the main wellbore, tool **22**B is deployed in the lateral wellbore **14**C, tool **22**C is deployed in the lateral wellbore **14**D, tool **22**D is deployed in the sub-lateral wellbore **14**F, and tool **22**E is deployed in the sub-lateral wellbore **14**G. It should be appreciated that additional or fewer tools may be deployed in a multi-lateral well. For example, some lateral wellbores or sub-lateral wellbore of a multi-lateral well may include multiple tools or may have no tools deployed therein. Further, it should be appreciated that the type of tools deployed throughout different lateral and sub-lateral wellbores of a multi-lateral well may vary.

**[0017]** Regardless of tool type, the tools **22**A-**22**E receive power and telemetry via respective conductive paths and segmentation modules. For example, tool **22**A receives power and telemetry signals via conductive path **16**A, segmentation module **20**A, and conductive path **16**B. Further, tool **22**B receives power and telemetry signals via conductive path **16**A, segmentation module **20**B, and conductive path **16**C. Further, tool **22**C receives power and telemetry signals via conductive path **16**A, segmentation module **20**C, and conductive path **16**D. Further, tool **22**D receives power and telemetry signals via conductive path **16**A, segmentation module **20**D, conductive path **16**E, segmentation module **20**E, and conductive path **16**F. Further, tool **22**E receives power and telemetry signals via conductive path **16**A, segmentation module **20**D, conductive path **16**E, segmentation module **20**F, and conductive path **16**G. The telemetry signals to the tools **22**A-**22**E may correspond to flow control commands, sensor configuration commands, on/off commands, or other commands. It should be appreciated that the tools **22**A-**22**E can also convey data or measurements to earth's surface via respective conductive paths and segmentation modules. Such data or measurements may be conveyed in response to a request, or in response to a schedule, trigger, or other programming.

**[0018]** Each of the segmentation modules **20**A-**20**F enables various features such as receiving combined power and telemetry signals from a conductive path, decoupling the power and telemetry signals, adjusting decoupled power or telemetry signals (e.g., boosting a telemetry signal or changing the current/voltage levels of the power signals), transmitting the decoupled power and telemetry signals between components, coupling the transmitted power and telemetry signals, and outputting the coupled power and telemetry signals to a subsequent conductive path. The operations may correspond to uplink operations or downlink operations. Further, each of the segmentation modules **20**A-**20**F may provide an on/off switch. Further, each of the segmentation modules **20**A-**20**F may enable physical disconnection and later reconnection of two conductive paths. Further, the segmentation modules **20**A-**20**F may include wireless transceivers and can communicate with each other wirelessly if within range of each other.

**[0019]** In at least some embodiments, a surface interface **26** couples to conductive path **16**A to receive sensor measurements from the segmentation modules **20**A-**20**F and/or the tools **22**A-**22**E. Further, the surface interface **26** may provide power and telemetry for downhole operations involving the tools **22**A-**22**E. Example components for the surface interface **26** include one or more power supplies, transmitter circuitry, receiver circuitry, data storage components, transducers, analog-to-digital converters, digital-to-analog converters. The surface interface **26** may be coupled to (e.g., via conductors **28**A, **28**B or wireless communication) or may include a computer system **60** that provides instructions for surface interface components, the segmentation modules **20**A-**20**F, and/or the downhole tools **22**A-**22**E. Further, the computer system **60** may process information received from the segmentation modules **20**A-**20**F and/or the downhole tools **22**A-**22**E. In different scenarios, the computer system **60** may direct the operations of the segmentation modules **20**A-**20**F and/or the downhole tools **22**A-**22**E. As an example, the computer system **60** may receive and analyze sensor measurements from the tools **22**A-**22**E to determine ICD settings related to the tools **22**A-**22**E. The computer system **60** may also display related information and/or control options to an operator. The interaction of the computer system **60** with the segmentation modules **20**A-**20**F and/or the downhole tools **22**A-**22**E may be automated and/or subject to user-input.

**[0020]** In at least some embodiments, the computer system **60** includes a processing unit **62** that displays logging/control options and/or results by executing software or instructions obtained from a local or remote non-transitory computer-readable medium **68**. The computer system **60** also may include input device(s) **66** (e.g., a keyboard, mouse, touchpad, etc.) and output device(s) **64** (e.g., a monitor, printer, etc.). Such input device(s) **66** and/or output device(s) **64** provide a user interface that enables an operator to interact with components of the segmentation modules **20**A-**20**F, the downhole tools **22**A-**22**E, and/or software executed by the processing unit **62**.

**[0021]** FIGS. **2** and **3** are schematic diagrams showing illustrative conductive path deployment options. In FIG. **2**, conductive path deployment option **30**A corresponds to a scenario where TEC **52** or another conductive path option is strapped to the outside of the production tubing string **50** by bands **54** that extend around the production tubing string **50**. For example, the bands **54** may be applied to hold the TEC **52** to the production tubing string **50** as the string **50** is lowered into the casing string **46**. Regardless of how the TEC **52** is attached to the production tubing string **50**, the conductive path deployment option **30**A of FIG. **2** corresponds to a scenario where the TEC **52** runs along the annular space between the production tubing string **50** and a larger diameter casing string **46**. Without limitation to other embodiments, the conductive path deployment option **30**A shows a surface well assembly **40** installed at earth's surface. The surface well assembly **40** may correspond to a "Christmas tree" or other assembly of valves, spools, and fittings connected to a top of a well **36** to direct and control a flow of fluids to and from the well **36**. In FIG. **2**, the TEC **52** is shown to exit the surface well assembly **40** and extend to a surface interface **26** that provides downlink power and telemetry signals (e.g., for tools **22**A-**22**E) and/or that processes uplink telemetry signals (e.g., from tools **22**A-**22**E).

**[0022]** In FIG. **3**, conductive path deployment option **30**B corresponds to a scenario where TEC **52** or another conductive path option runs along an interior of the production tubing string **50**. For example, the TEC **52** may be inserted into the production tubing string **50** as the string **50** is lowered into the casing string **46**. Without limitation to other embodiments, the conductive path deployment option **30**B shows a surface well assembly **40** installed at earth's surface. The surface well assembly **40** may correspond to a "Christmas tree" or other assembly of valves, spools, and fittings connected to a top of a well **36** to direct and control a flow of fluids to and from the well **36**. In FIG. **4**, the TEC **52** is shown to exit the surface well assembly **40** and extend to a surface interface **26** that provides downlink power and telemetry signals (e.g., for tools **22**A-**22**E) and/or that processes uplink telemetry signals (e.g., from tools **22**A-**22**E). In at least some embodiments, surface interface **26** and related components may correspond to an uphole interface rather than an interface at earth's surface (i.e., power supply and telemetry components need not be at earth's surface). In different embodiments, an uphole interface can be used in addition to, or instead of, surface interface **26**.

**[0023]** While FIGS. **2** and **3** represent deployment options along the interior of casing string **46**, it should be appreciated that it is possible to deploy at some portions of a conductive path along the exterior of the casing string **46**. For example, inductive coils and/or specialized casing segments can be used to convey power and telemetry signals from the exterior of the casing string **46** to its interior and vice versa. Such inductive coils can be considered to be part of a conductive path.

**[0024]** FIG. **4** is a block diagram showing an illustrative segmentation module **20**. As shown, the segmentation module **20** includes a housing **24** (e.g., a canister or other container) and a plug interface **70**. The plug interface **70** enables physical disconnection of the input conductive path from the segmentation module **20**. In different embodiments, the plug interface **70** may include part of the housing **24** or may be integrated with the housing **24**.

**[0025]** When plugged or unplugged, the housing **24** may provide a sealed compartment for the internal components. In some embodiments, any empty space within housing **24** may be occupied by fluid to comply with a pressure criterion. Once the fluid has filled any empty space, the housing **24** is sealed to prevent the fluid from leaking out of the housing **24**. In at least some embodiments, the fluid corresponds to a chemically inert (non-corrosive), non-magnetic, electrically insulating fluid such as air. In other embodiments, the fluid corresponds to a chemically inert, non-magnetic, electrically insulating, non-compressible fluid to provide further structural resilience to high pressure such as distilled water. In yet another embodiment, the fluid corresponds to a chemically inert magnetic fluid such as ferrofluids. The magnetic fluid enhances the magnetic permeability inside the housing **24**, which may increase signal-to-noise ratio (SNR) of short hop EM communications involving components inside the housing **24**.

**[0026]** In different embodiments, the material(s) and thickness of the housing **24** may vary. In at least some embodiments, the housing **24** is configured to satisfy at least one of a predetermined temperature criterion, a predetermined pressure criterion, a predetermined corrosion resistance criterion, a predetermined size criterion, and a predetermined electromagnetic transmissibility criterion, though in at least some embodiments each of these are satisfied to support operation in hostile downhole environments. For example, with regard to the predetermined temperature criterion and pressure criterion, at least some housing embodiments enable internal operations at ambient temperatures greater than 175° C. and at ambient pressures greater than 35,000 psi. Further, the housing **24** may have high tensile and compressive strength to withstand high pressures and shearing forces due to fluid pumping (e.g., during cementing).

**[0027]** With regard to the corrosion resistance criterion, at least some housing embodiments are comprised of material (s) resistant to corrosion during standard well completion practices, including cementation, stimulation (e.g., steam injection, acidization), hydraulic fracturing. With regard to the predetermined size criterion, the housing **24** may have a width of less than 1 inch (2.54 cm) and preferably less than 0.5 inches (1.27 cm). The predetermined size criteria may vary depending on how the segmentation module **20** is to be deployed in a downhole environment. For example, if the segmentation module **20** is to be deployed in the space between a casing string and a production string, then the gap (annulus) between the casing string and the production string may be used to determine the size criteria for housing **24**.

**[0028]** With regard to the electromagnetic transmissibility criterion, the housing **24** should be electromagnetically compatible with short hop EM communications involving components inside the housing **24**. This electromagnetic transmissibility criterion implies that the housing **24** should not significantly attenuate EM signals used for short hop communications. Further, the material(s) for housing **24** would be electrically resistive if not insulating to not significantly attenuate the EM field being measured. The electromagnetic transmissibility is a measure of the transmission of an EM field through the housing **24** relative to the EM field that would be measured in the absence of the housing **24**.

**[0029]** The housing **24** encloses various components including a decoupling/control unit **72** that receives power and telemetry signals from a conductive path, and that decouples the power and telemetry signals. For example, the power and telemetry signals can be decoupled using suitable inductive coils. The decoupling/control unit **72** may forward the decoupled telemetry signals to a first transceiver (TX/RX) **73** and may forward the decoupled power signals to a power transmission unit **74**. In at least some embodiments, the decoupling/control unit **72** includes a controllable on/off switch **71** that opens or closes the path to convey power and telemetry signals through the segmentation module **20**. In alternative embodiments, the on/off switch **71** can be positioned before or after the decoupling/control unit **72**.

**[0030]** The first transceiver **73** operates to wirelessly transmit decoupled telemetry signals to a second transceiver **76**. For example, the first transceiver **73** and second transceiver **76** may each include an antenna and suitable control circuitry to enable short hop communications between the first transceiver **73** and the second transceiver **76**. Further, the first transceiver **73** and/or second transceiver **76** may include circuitry to amplify, filter, or otherwise modify the decoupled telemetry signals. The power transmission unit **74** operates to convey decoupled power signals through the segmentation module **20**. In different embodiments, the power transmission unit **74** enables power transfer using inductive coils, acoustic transducers, capacitive electrodes, galvanic electrodes, or other power transfer options. Further, the power transmission unit **74** may include circuitry to amplify, filter, or otherwise modify the decoupled power signals. In some embodiments, the power transmission unit **74** can adjust the voltage and current levels conveyed to a tool deployed in a multi-lateral well. In at least some embodiments, the first transceiver **73**, second transceiver **76**, and power transmission unit **74** are configured to respectively convey decoupled telemetry and power signals in a manner that achieves maximum efficiency in both power and signal transmission. As appropriate to achieve maximum efficiency, different frequencies can be used to separately convey decoupled telemetry and power signals.

**[0031]** In different embodiments, a segmentation module **20** may be configured to convey decoupled power or telemetry signals wirelessly between a transmitter and a receiver. Additionally or alternatively, a segmentation module **20** may be configured to inductively convey decoupled power or telemetry signals between two coils. Additionally or alternatively, a segmentation module **20** may be configured to acoustically convey decoupled power or telemetry signals between two transducers. Additionally or alternatively, a segmentation module **20** may be configured to convey decoupled power or telemetry signals between capacitive electrodes. Additionally or alternatively, a segmentation module **20** may be configured to convey decoupled power or telemetry signals between galvanic electrodes.

**[0032]** The coupling unit **78** operates to couple the decoupled power and telemetry signals from other components of the segmentation module **20** (e.g., the power transmission unit **74** and the second transceiver **76**). As an example, the coupling unit **78** may include inductive coils and/or other circuitry to couple the power signals and telemetry signals together. Once coupled, the power signals and telemetry signals are output from the segmentation module **20** along a conductive path as described herein. The power signals and telemetry signals output from the segmentation module **20** are propagated along a conductive path to a subsequent segmentation module or tool (e.g., tools **22**A-**22**E).

**[0033]** While conveyance of power and telemetry signals is represented in FIG. **4** in a downlink direction, power or telemetry signals can be conveyed in the opposite direction (an uplink direction). For example, the segmentation module **20** may receive uplink data from a tool (e.g., one of tools **22**A-**22**E) via a respective conductive path. In such case, the uplink data may be transmitted from the second transceiver **76** to the first transceiver **72** and then output from the segmentation module **20** along a conductive path in an uplink direction (towards earth's surface). Circuitry of the segmentation module **20** (e.g., in the second transceiver **76** or the first transceiver **72**) may amplify, filter, or otherwise modify the uplink signals.

**[0034]** FIGS. **5**A and **5**B are schematic diagrams of illustrative lateral wellbores with ICDs. In scenario **100**A of FIG. **5**A, part of the multi-lateral well of FIG. **1** is represented. More specifically, lateral wellbore **14**C is shown extending from lower portion **14**B of the main wellbore, where respective casings strings or liners **114** and **116** are used to maintain the integrity of the lateral wellbore **14**C and the lower portion **14**B of the main wellbore.

**[0035]** As shown in scenario **100**A, an ICD **102** is deployed at or near perforations **110** along the casings string or liner **116** of lateral wellbore **14**C. The ICD **102** includes a tool body **104** and packers **102** that seal the lateral borehole against any flow other than that permitted through inlet **108** and tool body **104**. The ICD **102** includes internal components **112** such as a controllable valve, actuators, sensors, electronics to direct valve and sensor operations, electronics to receive and transmit information, data storage, rechargeable batteries, and/or other components. At least some of the internal components **112** operate in accordance with power and/or telemetry signals received from earth's surface via conductive path **16**A, segmentation module **20**B, and conductive path **16**C. Again, each segmentation module **20** supports various features such as receiving combined power and telemetry signals from a conductive path, decoupling the power and telemetry signals, adjusting decoupled power or telemetry signals (e.g., boosting a telemetry signal or changing the current/voltage levels of the power signals), transmitting the decoupled power and telemetry signals between components, coupling the transmitted power and telemetry signals, and outputting the coupled power and telemetry signals to a subsequent conductive path. Further, each segmentation module **20** may provide an on/off switch. Further, each segmentation module **20** may enable physical disconnection and later reconnection of two conductive paths.

**[0036]** As an example, ICD **102** may be equipped with various sensors for temperature, pressure, flow rates, and fluid properties. The collected sensor measurements are communicated via the conductive path **16**C, the segmentation module **20**B, and the conductive path **16**A to earth's surface, where the collected measurements are analyzed or otherwise processed. In some embodiments, a computer system at earth's surface (e.g., computer system **60**) may process the sensor measurements to determine appropriate valve settings. The valve settings and power needed to adjust the valve are provided (as power and telemetry signals) to the ICD **102** via the conductive path **16**A, the segmentation module **20**B, and the conductive path **16**C. In response to the received power and telemetry signals, the ICD **102** sets its controllable valve. This process can be repeated periodically. Alternatively, the settings for the ICD **102** can be adjusted based on a schedule (regardless of sensor measurements), triggers (e.g., a sensor measurement exceeding a threshold value or a threshold rate of change value), or user input.

**[0037]** Scenario **100**B of FIG. **5**B is similar to the scenario **100**A of FIG. **5**A, except that there is no casing string or liner in lateral wellbore **14**C. In other words, the ICD **120** in FIG. **5**B is deployed in an open wellbore. The components and operations of the ICD **120** of FIG. **5**B may be the same or are similar to the components and operations discussed for the ICD **102** of FIG. **5**A.

**[0038]** FIG. **6** is a flow chart showing an illustrative method **200** involving conductive paths with segmentation modules for decoupling power and telemetry for multilateral well tools. As shown, the method comprises deploying a plurality of tools in a multi-lateral well (block **202**). The tools may be deployed in open wellbores or cased wellbores as described herein. At block **204**, conductive path with a segmentation module is provided for each of a plurality of junctions with one or more of the tools. At block **205**, power and telemetry signals are transmitted from a surface interface (e.g., surface interface **26**). At block **206**, the power and telemetry signals are decoupled along at least one of the conductive paths using a respective segmentation module. At block **208**, the decoupled power and telemetry signals are coupled for transmission along at least one of the conductive paths using a respective segmentation module. In at least some embodiments, decoupled power or telemetry signals can be modified prior their being coupled again. For example, current/voltage levels of the power signals can be adjusted (e.g., the current level can be increased and the voltage level decreased by a segmentation module near a tool). In another example, telemetry signals can be amplified or filtered by one or more segmentation modules en route to a tool (or en route from a tool to earth's surface). The method **200** may additionally or alternatively include other operations related to the segmentation module features, tool features, data analysis features, and/or control features described herein.

**[0039]** Embodiments disclosed herein include:

**[0040]** A: A method that comprises deploying a tool in a well. The method also comprises providing a conductive path with a segmentation module in the well. The method also comprises conveying power and telemetry signals from a surface or uphole interface to the tool via the conductive path, wherein said conveying comprises the segmentation module decoupling and later coupling power and telemetry signals conveyed along the conductive path.

**[0041]** B: A system that comprises a tool deployed in a well. The system also comprises a conductive path with a segmentation module deployed in the well. The system also comprises a surface or uphole interface configured to transmit power and telemetry signals to the tool via the conductive path, wherein the segmentation module decouples and later couples power and telemetry signals conveyed along the conductive path.

**[0042]** Each of the embodiments, A and B, may have one or more of the following additional elements in any combination. Element 1: further comprising selectively disconnecting and reconnecting the conductive path at the segmentation module. Element 2: further comprising selectively switching off and switching on the conductive path at the segmentation module. Element 3: further comprising altering decoupled telemetry signals prior to said coupling. Element 4: further comprising altering decoupled power signals prior to said coupling. Element 5: further comprising conveying decoupled power or telemetry signals wirelessly between a transmitter and a receiver associated with the segmentation module. Element 6: further comprising inductively conveying decoupled power or telemetry signals between two coils associated with the segmentation module. Element 7: further comprising acoustically conveying decoupled power or telemetry signals between spaced transducers associated with the segmentation module. Element 8: further comprising conveying decoupled power or telemetry signals between capacitive electrodes associated with the segmentation module. Element 9: further comprising conveying decoupled power or telemetry signals between galvanic electrodes associated with the segmentation module.

**[0043]** Element 10: wherein the conductive path comprises at least one tubing encased conductor (TEC) coupled to the segmentation module. Element 11: wherein the segmentation module enables physical disconnection and reconnection of the conductive path. Element 12: wherein the segmentation module enables switching off and switching on of the conductive path. Element 13: wherein the segmentation module is configured to alter decoupled telemetry signals. Element 14: wherein the segmentation module is configured to alter decoupled power signals. Element 15: wherein the segmentation module is configured to convey decoupled power or telemetry signals wirelessly between a transmitter and a receiver. Element 16: wherein the segmentation module is configured to inductively convey decoupled power or telemetry signals between two coils. Element 17: wherein the segmentation module is configured to acoustically convey decoupled power or telemetry signals between two transducers. Element 18: wherein the segmentation module is configured to convey decoupled power or telemetry signals between capacitive electrodes. Element 19: wherein the segmentation module is configured to convey decoupled power or telemetry signals between galvanic electrodes.

**[0044]** Numerous variations and modifications will become apparent to those skilled in the art once the above disclosure is fully appreciated. For example, while multilateral well scenarios are described herein, it should be appreciated that one or more segmentation modules can be used in a single wellbore scenario. It is intended that, where applicable, the claims be interpreted to embrace all such variations and modifications.

**1**. A method that comprises:

deploying a tool in a well;

providing a conductive path with a segmentation module in the well; and

conveying power and telemetry signals from a surface or uphole interface to the tool via the conductive path, wherein said conveying comprises the segmentation module decoupling and later coupling power and telemetry signals conveyed along the conductive path.

**2**. The method of claim **1**, further comprising selectively disconnecting and reconnecting the conductive path at the segmentation module.

**3**. The method of claim **1**, further comprising selectively switching off and switching on the conductive path at the segmentation module.

**4**. The method of claim **1**, further comprising altering decoupled telemetry signals prior to said coupling.

**5**. The method of claim **1**, further comprising altering decoupled power signals prior to said coupling.

**6**. The method of claim **1**, further comprising conveying decoupled power or telemetry signals wirelessly between a transmitter and a receiver associated with the segmentation module.

**7**. The method of claim **1**, further comprising inductively conveying decoupled power or telemetry signals between two coils associated with the segmentation module.

**8**. The method of claim **1**, further comprising acoustically conveying decoupled power or telemetry signals between spaced transducers associated with the segmentation module.

**9**. The method of claim **1**, further comprising conveying decoupled power or telemetry signals between capacitive electrodes associated with the segmentation module.

**10**. The method of claim **1**, further comprising conveying decoupled power or telemetry signals between galvanic electrodes associated with the segmentation module.

**11**. A system that comprises:

a tool deployed in a well;

a conductive path with a segmentation module deployed in the well; and

a surface or uphole interface configured to transmit power and telemetry signals to the tool via the conductive path, wherein the segmentation module decouples and later couples power and telemetry signals conveyed along the conductive path.

**12**. The system of claim **11**, wherein the conductive path comprises at least one tubing encased conductor (TEC) coupled to the segmentation module.

**13**. The system of claim **11**, wherein the segmentation module enables physical disconnection and reconnection of the conductive path.

**14**. The system of claim **11**, wherein the segmentation module enables switching off and switching on of the conductive path.

**15**. The system of claim **11**, wherein the segmentation module is configured to alter decoupled telemetry signals.

**16**. The system of claim **11**, wherein the segmentation module is configured to alter decoupled power signals.

**17**. The system of claim **11**, wherein the segmentation module is configured to convey decoupled power or telemetry signals wirelessly between a transmitter and a receiver.

**18**. The system of claim **11**, wherein the segmentation module is configured to inductively convey decoupled power or telemetry signals between two coils.

**19**. The system of claim **11**, wherein the segmentation module is configured to acoustically convey decoupled power or telemetry signals between two transducers.

**20**. The system of claim **11**, wherein the segmentation module is configured to convey decoupled power or telemetry signals between capacitive electrodes.

**21**. (canceled)

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